

# INVIVOSTAT

## Chi-squared and Fisher’s Exact Test

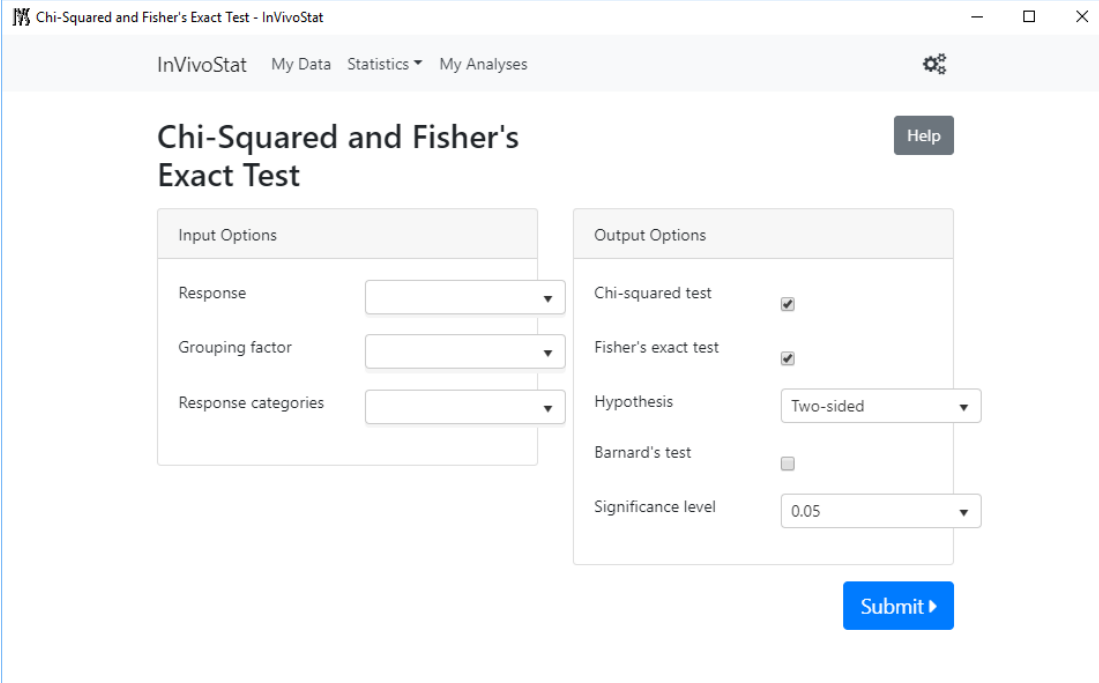
### User Guide

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## 1 Introduction

The Chi-squared and Fisher's Exact Test module in InVivoStat is available from the Statistics drop-down menu entitled 'Chi-squared and Fisher's Exact Test'. The user interface is:



The screenshot shows the InVivoStat web interface for the 'Chi-Squared and Fisher's Exact Test' module. The page title is 'Chi-Squared and Fisher's Exact Test - InVivoStat'. The navigation bar includes 'InVivoStat', 'My Data', 'Statistics', and 'My Analyses'. The main heading is 'Chi-Squared and Fisher's Exact Test' with a 'Help' button. The interface is divided into two main sections: 'Input Options' and 'Output Options'. The 'Input Options' section contains three dropdown menus: 'Response', 'Grouping factor', and 'Response categories'. The 'Output Options' section contains several options: 'Chi-squared test' (checked), 'Fisher's exact test' (checked), 'Hypothesis' (set to 'Two-sided'), 'Barnard's test' (unchecked), and 'Significance level' (set to '0.05'). A blue 'Submit' button is located at the bottom right of the form.

The Chi-squared and Fisher's Exact Test module performs Chi-squared test, Fisher's Exact test and Barnard's test for categorical data. The analysis can be performed on a response which is categorised into two or more categories and so is appropriate if the response outcome measured is binary.

As a rule of thumb Fisher's Exact test should be used instead of the Chi-squared test when the number of counts for any individual response/treatment combination is less than 5.

While not as well-known as Fisher's, it may be more appropriate test to use. Fisher's Exact test assumes the row and column totals (i.e. the individual group sizes and total number of responders and non-responders across all treatment groups) are fixed. While this is probably true for the individual group sizes it is rarely the case for the total number of responders.

## 2 Dataset format

The Chi-squared and Fisher’s Exact Test module accepts data in the form of a contingency table.

For example, in this experiment there were 40 animals in the Drug treated group and 36 animals in the Vehicle control group. The response for each animal was classed as either a ‘pass’ or a ‘fail’. There were 19 passes in the drug treated group and 23 passes in the vehicle control group. The dataset was set up ready for InVivoStat as follows:

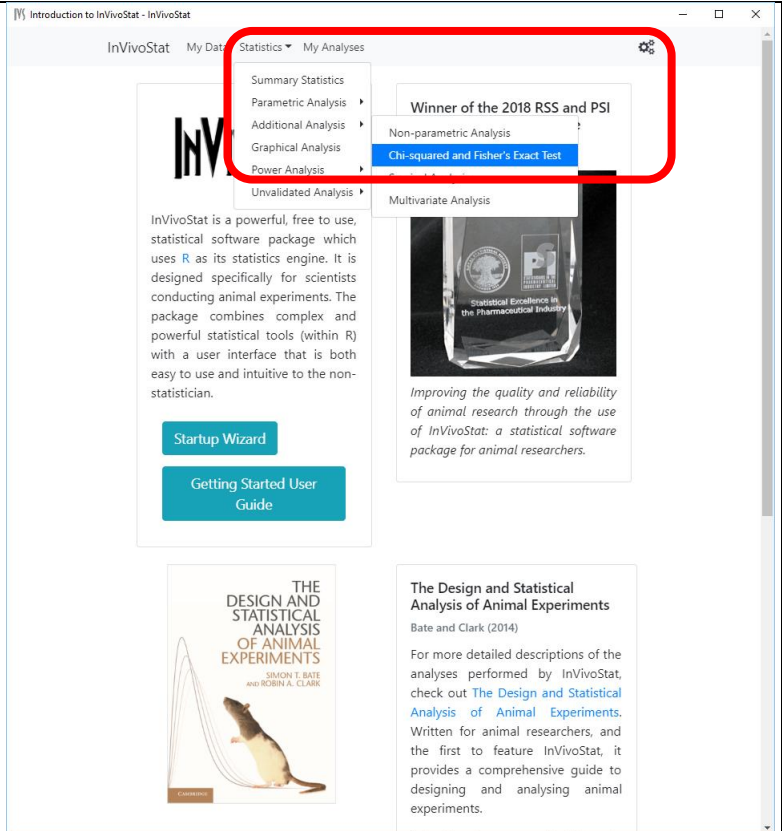
Count	Response	Treatment
19	PASS	Drug
21	FAIL	Drug
23	PASS	Vehicle
13	FAIL	Vehicle

## 3 Analysis procedure

The steps required to perform an analysis are described in this section.

### 3.1 Select the analysis module

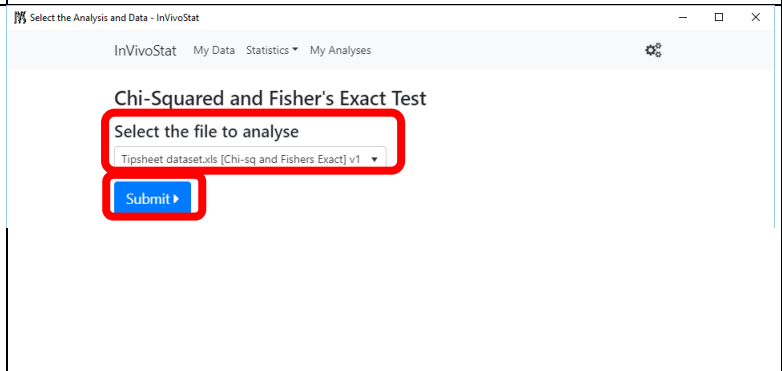
The analysis begins by selecting the Chi-squared and Fisher’s Exact Test module from the drop-down list of available modules.



### 3.2 Select the dataset to be analysed

Once the module is selected, the dataset is chosen from the drop-down list of available datasets.

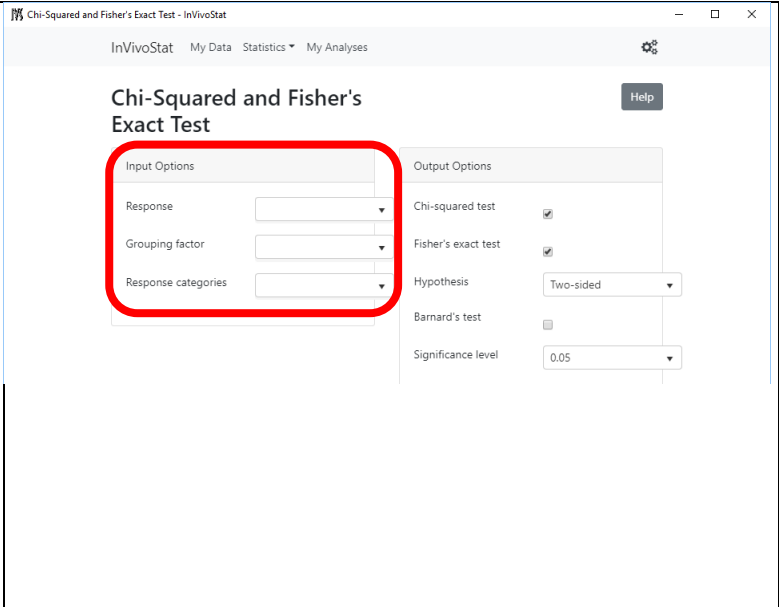
Click ‘Submit’.



### 3.3 Select the response to analyse and terms to include in the statistical model

Once the dataset has been selected, the user selects the response variable to analyse by clicking on the Responses box and selecting the response variable to analyse.

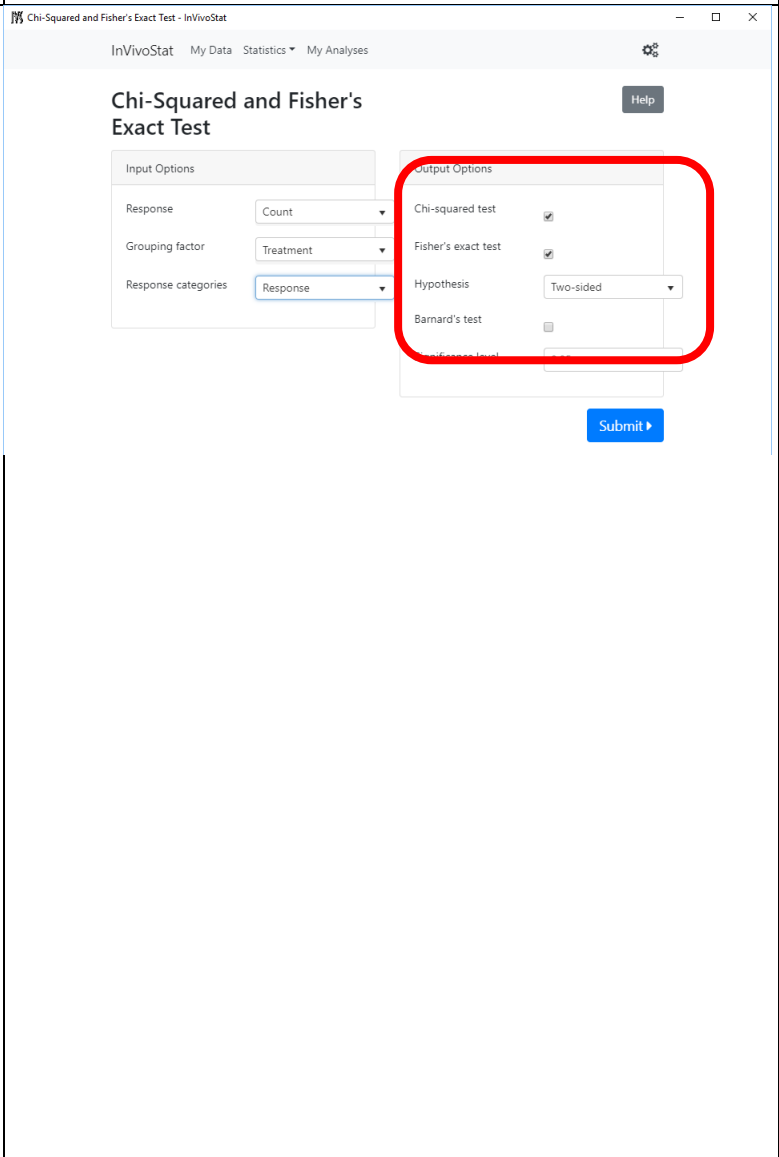
Similarly, the user should select the grouping factor and the variable defining the response categories.



### 3.4 Select the overall analysis results

There are several results that are available. These are selected before running the analysis and include:

- 1) Chi-squared test  
Produces the results of the Chi-squared test of equality of proportions.
- 2) Fisher's Exact test  
Produces the results of the Fisher's Exact test of equality of proportions.
- 3) Barnard's test  
Barnard's test is an alternative test to Fisher's Exact test.
- 4) Hypothesis  
The default hypothesis that is performed is two-sided. This option can be changed to a one-sided hypothesis (less than or greater than) when the Fisher's Exact test (2 x 2 case) has been selected.
- 5) Significance level  
The significance level default is 0.05, or 5%, although this can be changed.



### 3.5 Run the analysis

Click 'Submit' to run the analysis.

## 4 Output results

### Response

InVivoStat identifies the response being analysed and the treatment and response categories variables.

### Contingency table of counts

InVivoStat produces a table of the counts categorised by the treatment factor and the response categories. This is useful if there are multiple replicates of each of the factor combinations present in the dataset.

### Table of expected counts

This table gives the expected results under the null hypothesis of no association between the treatment factor and the response categories.

### Chi-squared test table

This table gives results of the Chi-squared test. For the 2 x 2 case the test is calculated using Yates' continuity correction.

### Fisher's Exact test table

This table gives results of the Fisher's Exact test.

### Barnard's test table

This table gives results of the Barnard's test.

### References

A list of references for the methods applied in the analysis.

### Analysis options

A list of the variables and output options used to generate the output.

## 5 Test dataset example output

### 5.1 InVivoStat options

### 5.2 Sample output

**InVivoStat Chi-squared Test and Fisher's Exact Test**

### Response

The Count response is currently being analysed by the Chi-squared Test and Fisher's Exact Test module. The response is separated into categories, as defined by the factors Treatment and Response.

Note, this module should be used to analyse count data that can be expressed in the form of a contingency table. These tests assess the significance of the association (contingency) between the two treatment classifications.

For more information on the theoretical approaches that are implemented within this module, see Bate and Clark (2014).

### Contingency table of counts

	FAIL	PASS
Drug	21	19
Vehicle	13	23

The values in this table are the sum of the individual entries in the imported dataset.



## Table of expected results (under the null hypothesis of no association)

	FAIL	PASS	Column totals
Drug	17.89	22.11	40
Vehicle	16.11	19.89	36
Row totals	34	42	76

The values in this table are the expected results, given the row and column totals, under the assumption of no association between the two factors.

## Chi-squared test

	Test statistic	Degrees of freedom	p-value
Result	1.45	1	0.2287

Note: For the 2 x 2 case, the chi-squared test is calculated with Yates' continuity correction.

The chi-squared test is not significant at the 5% level of significance as the p-value is greater than 0.05.

## Fisher's exact test

	p-value
Result	0.1724

The Fisher's exact test is not significant at the 5% level of significance as the p-value is greater than 0.05.

## Statistical references

Bate ST and Clark RA. (2014). *The Design and Statistical Analysis of Animal Experiments*. Cambridge University Press.

Lyderson S, Fagerland MW and Laake P. (2009). Recommended tests for association in 2 x 2 tables. *Statistics in Medicine*, 28, 1159-1175.

## R references

R Development Core Team (2013). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria. URL <http://www.R-project.org>.

Lecoutre, Eric (2003). *The R2HTML Package*. R News, Vol 3. N. 3, Vienna, Austria.

## Analysis options

Response variable: Count

Grouping variable: Treatment

Response categories variable: Response

Chi-squared test (Y/N): Y

Fisher's Exact test (Y/N): Y

Barnard's Exact test (Y/N): N

One- or two-sided test: Two-sided

Significance level: 0.05